

Regulatory Framework for Occupational Exposure Management in Pakistan

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Abstract: Pakistan Nuclear Regulatory Authority (PNRA) is the national statutory body empowered to control, regulate and supervise all matters related to nuclear safety and radiation protection at nuclear power plants and radiation facilities in the country. PNRA has issued several regulations and guides as part of its regulatory framework on radiation protection for management of / reducing occupational exposures. A comprehensive inspection program and evaluation of licenses submissions are the tools used by regulatory authority to assess licensee efforts for reducing and managing occupational exposures at nuclear power plants.

This paper briefly describes the radiation protection regulatory framework and trend analysis of occupational exposures at chashma nuclear power plant during normal operation and refueling outages.

Key words: *regulatory framework; national radiation protection regulations, occupational exposures, chashma nuclear power plant*

1. Introduction

The existence of a framework to regulate radiation protection and manage occupational exposures in the country was recognized way back in 1965 when the first research reactor PARR-1 was commissioned. A local setup was established to look after radiation protection matters according to internationally acceptable standards. The first legislative setup to govern radiation protection in the country was established as "Directorate of Nuclear Safety and Radiation Protection" (DNSRP) in 1984 within Pakistan Atomic Energy Commission (PAEC). In 1994, Pakistan signed the International Convention on Nuclear Safety and ratified it in 1997. To fulfill its obligations of establishing an independent nuclear regulatory body entrusted with the implementation of the legislative and regulatory framework governing nuclear power and radiation use in the country, and further to separate the regulatory functions from the promotional aspects of the nuclear program, Pakistan Nuclear Regulatory Board (PNRB) was established as an interim measure. Complete separation of promotion and regulatory functions and responsibilities was achieved in 2001, when the President of Pakistan promulgated the Pakistan Nuclear Regulatory Authority Ordinance. Consequently, Pakistan Nuclear Regulatory Authority (PNRA) was created as a competent and independent body for the regulation of nuclear safety and radiation protection in Pakistan.

PNRA is empowered to control, regulate and supervise all matters related to Nuclear Safety and Radiation Protection in Pakistan. To discharge its regulatory obligations in an effective manner PNRA is authorized to devise, adopt, make and enforce rules, regulations, orders or codes of practice for nuclear safety and radiation protection and to plan, develop and execute comprehensive policies and programs for the protection of life, health and property against the risk of ionizing radiation. PNRA regulates the radiation safety aspects of nuclear installations e.g. nuclear power plants, nuclear research reactors etc. and radiation facilities e.g. diagnostic radiology and radiotherapy centers, nuclear medicine facilities, irradiators, industrial and agricultural radiography etc.

The mission of PNRA is “to ensure safe operation of nuclear and radiation facilities, and to protect the radiation workers, general public and the environment from the harmful effects of ionizing radiation by formulating and implementing effective regulations and building a relationship of trust with the licensees and maintaining transparency in actions and decisions taken by it.”

2. Regulatory Framework in Pakistan

PNRA has developed necessary regulatory infrastructure in the country regarding radiation protection practices. Many national regulations have been formulated and many others are in process. These regulations are consistent with the International Nuclear Safety Standards. To date PNRA has issued the following regulations concerning nuclear and radiation safety in Pakistan:

- Regulations on Radiation Protection (PAK/904)
- Regulations for the licensing of Radiation Facilities other than nuclear installations (PAK/908)
- Regulation for Licensing of Nuclear Installation (s) in Pakistan (PAK/909)
- Regulations on Safety of Nuclear Power Plants - Design (PAK/911)
- Regulations on Safety of Nuclear Power Plants - Quality Assurance (PAK/912)
- Regulations on Safety of Nuclear Power Plants – Operations (PAK/913)
- Regulations on Management of a Nuclear or Radiological Emergency (PAK/914)
- Regulations on Radioactive Waste Management (PAK/915)
- Regulations for Safe Transport of Radioactive Material (PAK/916)

Regulation on Radiation Protection PAK/904 is based on BSS-115 and national experiences. The main features include that no practice shall be licensed or authorized unless it produces sufficient benefit to individuals to be exposed or to society to offset the radiation harm that it might cause, taking into account social, economic and other relevant factors. The annual occupational exposure is limited up to 20 mSv.

Regulation for Licensing of Nuclear Installation (s) in Pakistan PAK/909 establishes a system of licensing for the nuclear installations which sets requirements for site registration, construction license, fuel load permit, operation license, license beyond design life, inspections and submission of radiation protection program from the licensee.

Regulations on Safety of Nuclear Power Plants-Design PAK/911 establish requirements for the safe design of nuclear installations. This regulation is mainly based on IAEA nuclear safety standard NS-R-1 and on the national experiences.

Regulations on the Safety of Nuclear Power Plants Operations PAK/913, is based on IAEA Safety Standards NS-R-2 and national experiences. These regulations deal with the safety aspects of management, commissioning, operation and decommissioning of nuclear power plant. These regulations also provide the essential requirements that must be met during operation of land based stationary thermal neutron reactor nuclear power plant. The purpose of these regulations is to provide assurance that operational activities are carried out without undue radiological hazards to the general public and to individuals on site.

Regulations on Management of a Radiological or Nuclear Emergency PAK/914 is based on GSR-2, local government rules and national experiences. These regulations establish the requirements for an adequate level of preparedness and response for a nuclear or radiological

emergency. Their implementation is intended to minimize the consequences for people, property and the environment of any nuclear or radiological emergency.

3. National Radiation Protection Regulations

Pakistan nuclear safety and radiation protection regulations (PNSRP) were promulgated in 1990. Until 2004 these have been serving as national regulations for radiation protection. The annual occupational exposure regulatory limit was 50 mSv in accordance with IAEA Safety Standards Series-9 in these regulations ⁽¹⁾. IAEA BSS 115 published in 1998 recommended an effective dose of 20mSv/year averaged over five consecutive years as occupational exposure dose limit. PNRB* carried out a study in 1998 to evaluate the implementation of new dose limit ⁽²⁾. The only operating NPP at that time i.e. KANUPP dose distribution was evaluated and found that 99% of the work force remained below 20 mSv/year. It was then concluded that new restrictive dose limit can be met and eventually through addendum to PNSRP Regulations in 1998 new standards were made national regulatory requirement. In year 2004 new national regulations on radiation protection (PAK/904) were promulgated which are based on IAEA BSS and national experiences. Regulations on radiation protection set various requirements for establishment and safe operation of nuclear and radiation facilities. According to these regulations ⁽³⁾ no practice can be licensed or authorized in the country unless it produces sufficient benefit to individuals to be exposed or to society to offset the radiation harm that it might cause, taking into account social, economic and other relevant factors. Another key issue addressed in these regulations is requirements for designation of radiation protection officers at facilities. These regulations bound the licensee for establishing and implementing technical and organizational measures that are needed for ensuring protection and safety for the practices and sources for which they are licensed and for compliance with all applicable requirements of these regulations. These regulations also provide radionuclide contamination levels in edible goods which are imported or marketed in the country. Dose limitations for occupational workers, public and guidance levels for patient doses are also provided in these regulations.

4. Mechanism to regulate radiation protection at nuclear power plants and radiation facilities

The authority has a developed mechanism to regulate radiation protection at nuclear power plants and radiation facilities. This mechanism is based on evaluation of licensee submissions and a comprehensive inspection program.

The national regulations require the licensee of nuclear power plant to submit the radiation protection program before fuel loading which is reviewed and agreed by authority before its implementation. Similarly Licensee also submits its dosimetry program and subsequently dose records of all radiation workers. The authority maintains a database of dose records of all regular and contract radiation workers. The database provides oversight of annual dose, average five year dose and control of itinerant workers. The licensee submits dose estimation of refueling outages, bases for estimation, and the methodology adopted / procedures followed for estimation. After the refueling licensee submits assessment report on doses received by the workers along with details of doses received during the refueling outage including overall dose, doses received by individuals, doses received in specific activities in high radiation areas, overexposure of individual, if any, and comparison with the estimated doses for the outage. All these submissions are critically reviewed in the light national regulations, past experiences and international practices. Before granting construction license and fuel load

* (See Introduction Para 1)

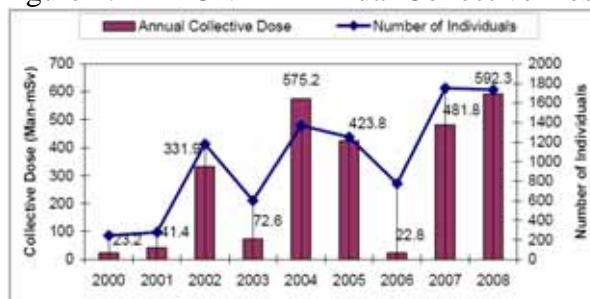
permit to a new nuclear power plant the authority reviews Preliminary Safety Analysis Report (PSAR) and Final Safety Analysis Report (FSAR) respectively. This review focuses inter alia policy, design and operational considerations for radiation protection and ALARA implementation, contained, airborne and accident source terms, radiation protection design features, dose assessment methodology and health physics program. Similarly emergency planning and preparedness plan is submitted, reviewed and agreed by authority before fuel loading and this program is demonstrated through exercise before commencing the operation. For radiation facilities the authority evaluates licensee submissions regarding shielding design, facility layout, available radioactive materials and radiation protection plans.

The inspection program ⁽⁴⁾ of the authority comprises on various types of inspections like planned inspections, reactive inspections, announced and unannounced inspections, periodic inspections, etc. These regulatory inspections are conducted by PNRA headquarter directorates and three regional nuclear safety directorates in the country, established in Islamabad, Karachi, and Kundian. Such inspections are conducted for nuclear installations and radiation facilities to verify that regulatory safety standards are comprehensively observed by the operators. During inspections, PNRA verifies, among other matters, availability of personal protective gears; qualified Radiation Protection Officer (RPO); personal and area monitoring equipment; radiation dose records; and physical protection and security measures.

5. Trend of Occupational Exposures at Chashma Nuclear Power Plant

The NPPs in Pakistan have developed policies and procedures, for the protection of workers from the harmful effects of ionizing radiation. Monitoring programs for workers external as well as internal exposure should be in place. In the external exposure monitoring program all the plant personnel are required to wear electronic pocket dosimeter when entering radiation controlled area. All radiation workers are also provided TLD badges to be put on in radiation controlled area at all times. Personnel also undergo internal exposure monitoring through whole body counting. In addition to personnel monitoring program, contamination control program which consists of multiple methods of controlling the spread of contamination to personnel and equipment within the plant should also be in place.

Figure 1: CNPP-I Annual Collective Dose



Chashma Nuclear Power Plant-1 (CNPP-I) started operation in September 2000. CNPP-I is a two loop pressurized water reactor (PWR) with gross output 325MWe and a net output of 300MWe. CNPP-I started its commercial operation in September 2000; it has now completed its eight years of operation in September 2008 including five Refueling outages (RFO) in years 2002, 2004, 2005, 2007 and 2008-2009.

Analysis of CNPP-I occupational exposure record reveals that average individual dose and maximum individual dose remained far below the annual dose limit. Annual collective dose shows a uniform trend during refueling outage years and years with no refueling outage

respectively. Trend analysis of collective dose and total number of individuals exposed to radiation at CNPP-I during years 2000 to 2008 is presented in figure-1. Annual collective dose of radiation workers remain between 20-70 Man-mSv during years 2000, 2001, 2003 and 2006; when no refueling outage was performed. During refueling outage years; 2002, 2004, 2005, 2007 and 2008 annual collective dose remained between 330-593Man-mSv.

Review and analysis of dose records of CNPP-I reveals that the doses received by the workers are well below the regulatory limits established by PNRA ⁽⁵⁾. On the whole it is assessed that the ALARA philosophy is being applied for the control of occupational exposure for all work in radiation areas, including maintenance, repairs, refueling, etc.

6. Conclusion

PNRA has established a functional radiation protection regulatory framework in the country and has developed a comprehensive mechanism for implementation of this framework. The evaluations of occupational exposures at operational NPPs in the country shows that they are within national occupation exposure dose limits. PNRA is striving for continuous improvement of this framework and mechanism in the light of changing international standards and national experiences.

References:

1. Pakistan nuclear safety and radiation protection regulations (PNSRP Regulations 1990)
2. Jawad A. HASHMI, Bushra NASIM, Implementation and management of ALARA in nuclear power plants in accordance with new basic safety standards experience in Pakistan. 1998.
3. Regulations on radiation protection (PAK/904), 2004
4. PNRA Inspection Program for Nuclear Power Plants, 2008
5. CNPP-I Annual dose reports 2000-2008